United States Patent

Mermelstein

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[45] **May 9, 1972**

[54] **APPARATUS FOR STABILIZING A ROTARY SAW BLADE**

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[21] Appl. No.: **73,009**

[52] **U.S. Cl.** .....**83/676,** 83/201.15, 143/160 R

[51] **Int. Cl.**.....**B26d 1/12**

[58] **Field of Search**.....143/160 R; 83/201.15, 676

[56] **References Cited**

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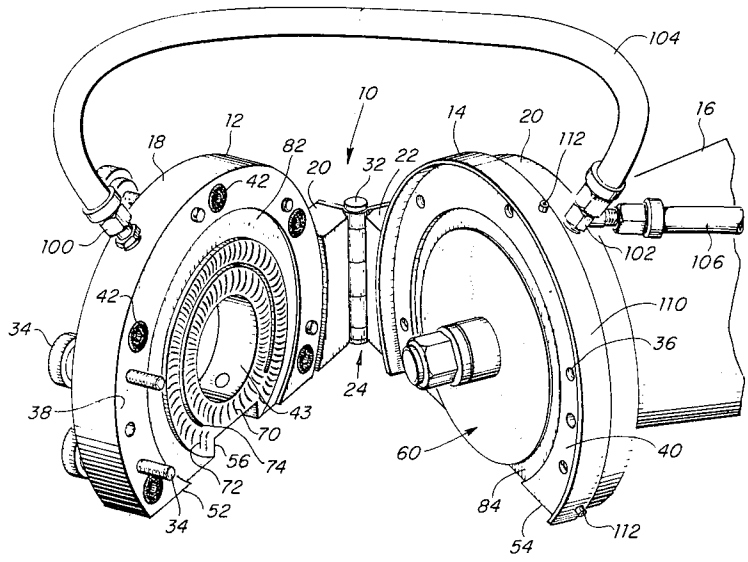
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Assistant Examiner—David R. Melton
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[57] **ABSTRACT**

A guide for a rotary saw blade comprising a housing having two inner opposed guide surfaces that define a space for receiving a saw blade mounted on a rotatable arbor and including means for directing a liquid under pressure against the opposite faces of the blade during rotation thereof so as to hydrodynamically stabilize the blade.

18 Claims, 5 Drawing Figures



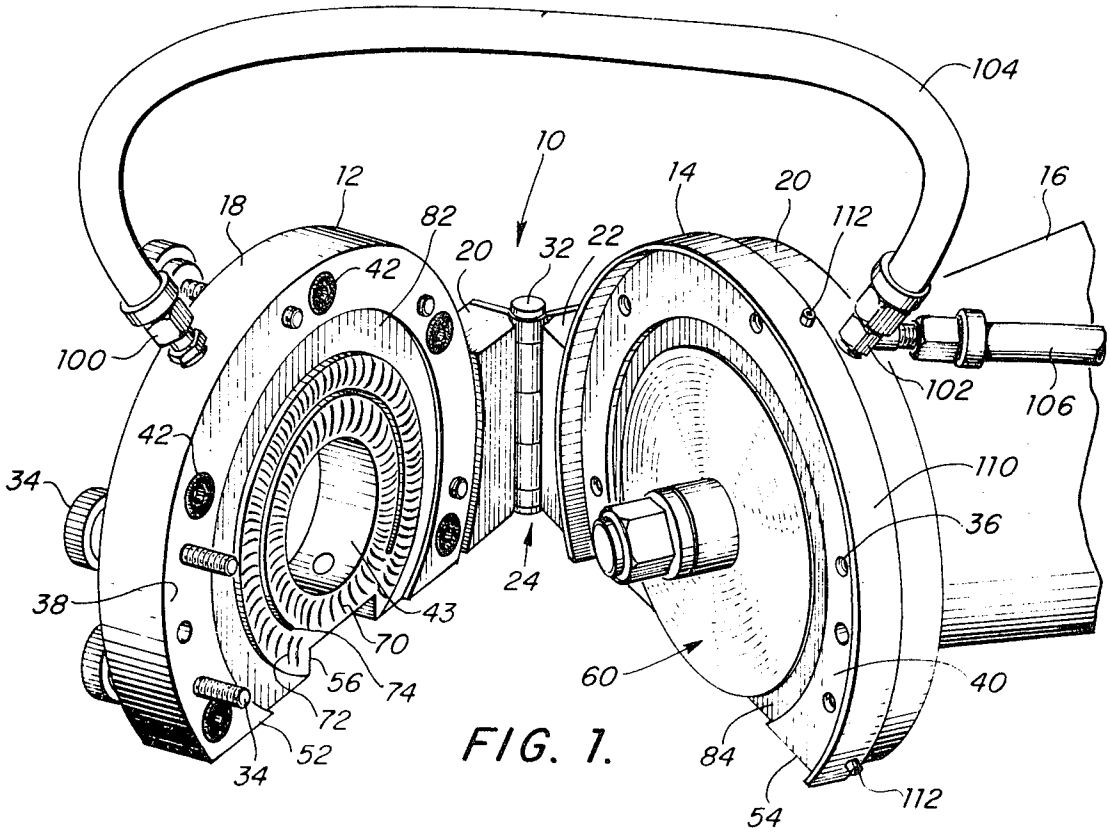


FIG. 1.

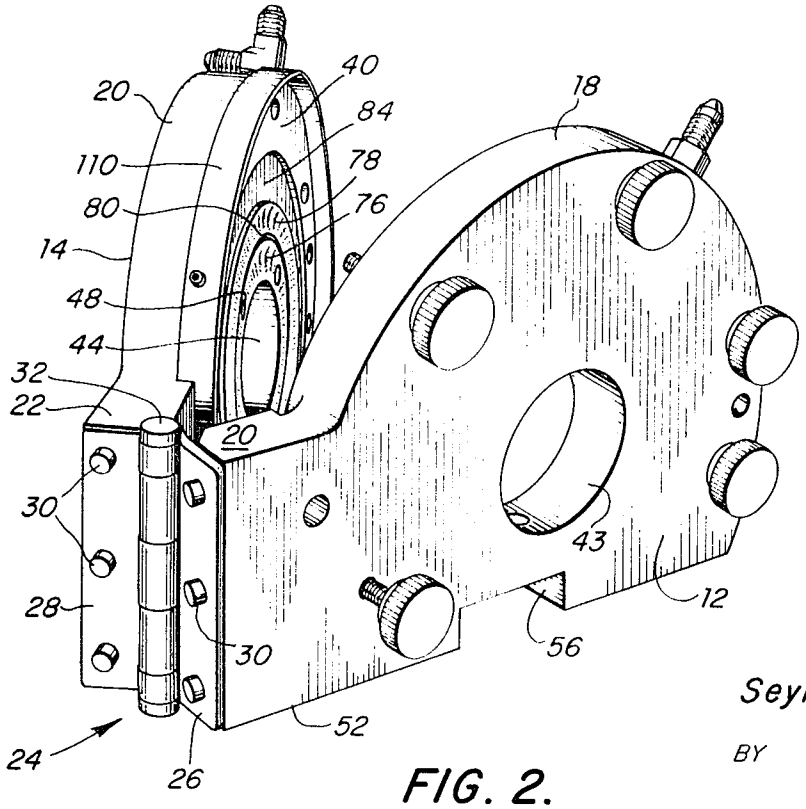


FIG. 2.

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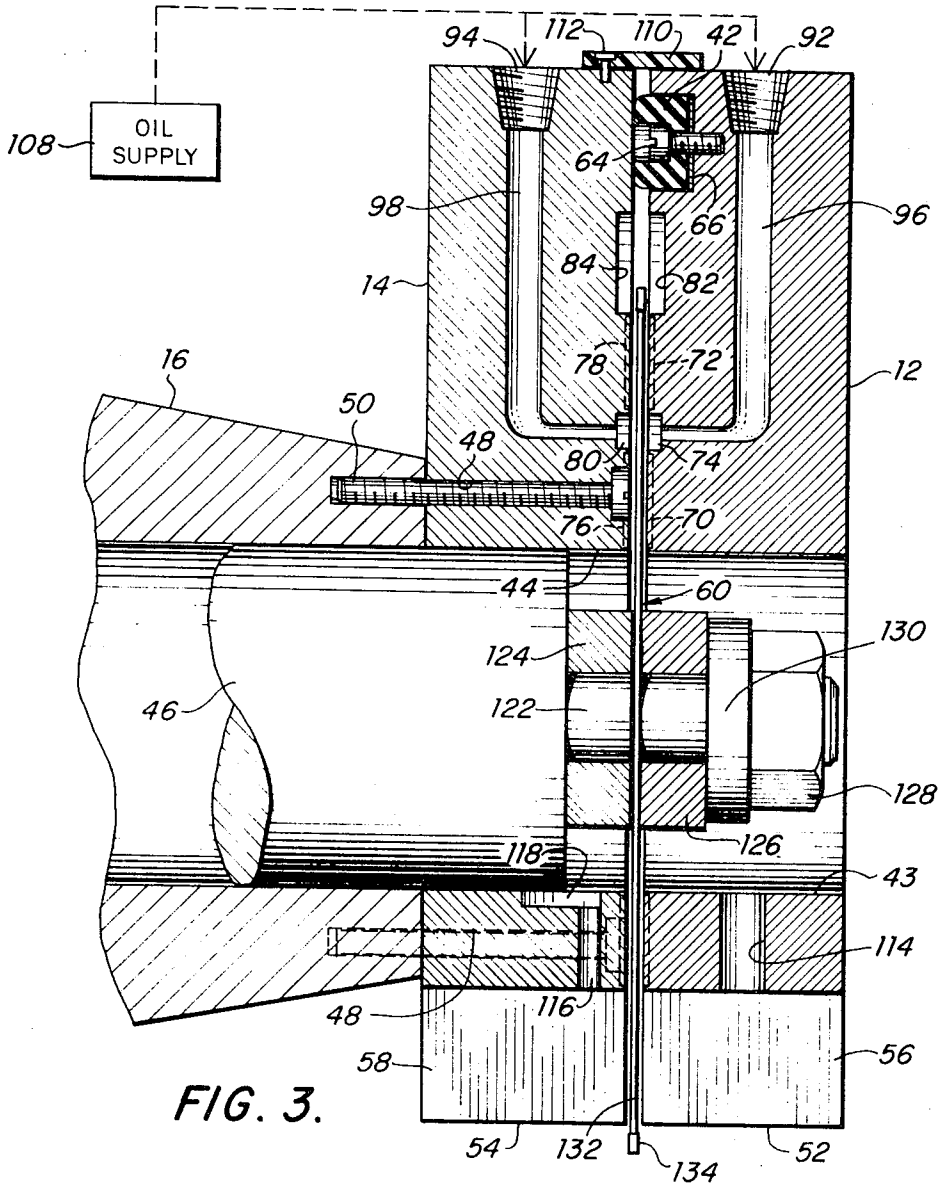


FIG. 3.

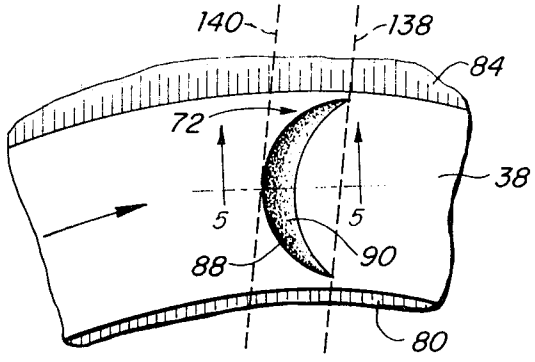


FIG. 4.

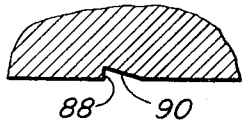


FIG. 5.

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APPARATUS FOR STABILIZING A ROTARY SAW BLADE

The present invention relates to a saw blade guide and in particular to a guide for hydrodynamically stabilizing a rotary saw blade.

A number of industrial processes involve the use of circular saw blades to cut or slice selected and expensive materials such as semiconductor crystals, ceramics, and metals. For example, wafering machines exist for slicing quartz and semiconductor crystals into thin wafers or chips. In such applications cutting accuracy and the ability to make a fine cut with small loss of material as sawdust are extremely important, both with respect to quality of the end product and materials cost. Accordingly the usual practice is to use a thin saw blade operating at high speeds. However, it has been found that the efficiency of such cutting operations is hampered not only by generation of heat but also by lateral vibration or deflection of the thin saw blade. Other problems involve rapid saw blade wear and dressing the cutting edge of the saw blade.

Therefore, the primary object of the present invention is to provide a new and improved saw blade guide which overcomes the disadvantages of the prior art.

Another object of the present invention is to provide a guide for hydrodynamically stabilizing a saw blade.

Still another object of the present invention is to provide a saw blade guide which is adapted to simultaneously cool the saw blade and stabilize it against vibration.

A further object of the present invention is to provide a guide for stabilizing a thin circular saw blade so that the latter can accurately and precisely cut and slice a workpiece.

Yet another object is to provide a saw blade stabilizing means which minimizes blade wear and facilitates dressing square edged circular saw blades.

Still other objects are to provide a saw blade guide in which the blade does not contact the guide and in which the spacing between the guide and the blade is adjustable.

The above and other objects, advantages, and features of the present invention are accomplished by providing a housing having first and second inner opposed surfaces spaced from one another so as to define a space for receiving a rotary saw blade whose opposite side faces are spaced from the said opposed surfaces. The housing has a side opening for accommodating the rotatable arbor on which the saw blade is mounted and also another opening through which the blade extends for engaging a workpiece. Means are provided for injecting a liquid into the space and for directing the liquid against the opposite faces of the blade during rotation thereof so as to substantially hydrodynamically stabilize the blade.

For a fuller understanding of the nature of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view showing the saw blade guide of the present invention in open position;

FIG 2 is another perspective view of the same guide;

FIG. 3 is a cross-sectional view of the same guide in operative position;

FIG. 4 is an enlarged view of a portion of one of the interior surfaces of the same guide; and

FIG. 5 is a sectional view taken along the line 5—5 in FIG. 4.

Referring now to FIG. 1, the saw blade guide of the present invention comprises a housing **10**, formed in two parts **12** and **14**, which is adapted to be mounted on the end of an arbor housing **16** which forms part of a motorized rotary saw machine (not shown). Housing members **12** and **14** have arcuately shaped outer surfaces **18** and **20** respectively and, except as otherwise noted below, they are of substantially identical configuration, and size. Formed integral with members **12** and **14** are block-like extensions **20** and **22** respectively which serve as anchoring points for a double leaf hinge **24**. The latter includes two complementary hinge plates **26** and **28** which are secured to extensions **20** and **22** respectively by, for example, machine screws **30** and are pivotally secured together by a hinge pin **32** which preferably fits very loosely in position for a reason to be explained later.

The member **12** has a plurality of rotatable thumbscrews **34** passing transversely therethrough the spaced around the periphery thereof. The member **14** has a plurality of threaded holes **36** in its inner surface **40** located so that when members **12** and **14** are pivoted into confronting relation with each other, thumbscrews **34** may be screwed into holes **36** and thereby lock members **14** and **16** to one another. Spaced from one another and mounted in the inner surface **38** of member **12** are a plurality of stop pads **42** which are designed to bear against surface **40** of member **14** when members **12** and **14** are brought together as described above. A detailed description of stop pads **42** is presented hereinafter. Members **12** and **14** each have cylindrically shaped holes **43** and **44** which are axially aligned with one another and are disposed substantially orthogonally with respect to inner surfaces **38** and **40**. Hole **43** is sized so as to make a snug sliding fit with a saw blade arbor **46** which is rotatably supported in arbor housing **16** to which guide housing **10** is affixed and hole **44** permits access to the end of the arbor without need for opening the guide housing. The member **14** of guide housing **10** is affixed to and supported by arbor housing **16**. As seen in FIG. **3**, this is achieved by providing in the guide housing member **14** a plurality of countersunk holes **48** disposed concentrically about hole **44** to accomodate cap screws **50** which screw into tapped holes in the end face of the arbor housing **16**.

Members **12** and **14** preferably have relatively flat bottom surfaces **52** and **54** respectively. These bottom surfaces are provided with like-shaped slots **56** and **58** which are aligned when the members are locked together to form a continuous slot to accommodate a workpiece which is to be sliced or cut by a saw blade **60** affixed to arbor **46**. Although as shown, slots **56** and **58** are oriented substantially orthogonally with respect to inner surfaces **38** and **40**, slots **56** and **58** may be oriented at some angle other than 90° with respect to surfaces **38** and **40**, e.g. oriented so that the saw blade will slice a quartz crystal at an angle of 35°, 17 minutes to what is called an AT cut.

FIG. **3** shows in cross section one of the stop pads **42**. Each of the pads is mounted in a cavity in inner surface **38** of member **12**. Pads **42** may be made of plastic or hard rubber or other suitable material and have countersunk holes to receive capscrews **64** which screw into tapped holes in member **12**. The extent to which the pads **42** project from the surface **38** of member **12** is adjustable by insertion of one or more shims **66** as shown of appropriate thickness. The setting of stop pads **42** in member **12** determines the spacing between the surfaces **38** and **40** when the members **12** and **14** are locked together by engagement of thumbscrews **34**. As explained earlier, hinge pin **32** is loose fitting so that despite the hinged connection between them, when members **12** and **14** are locked together their surfaces **38** and **40** will be parallel to each other and to the opposite faces of saw blade **60**.

The inner surface **38** of member **12** has two series of like depressions **70** and **72** disposed in circularly extending arrays concentric with side opening **43** and separated from each other by a narrow channel **74**. The inner surface **40** of member **14** has two like arrays of identical depressions **76** and **78** separated by a like circularly extending narrow channel **80** concentric with side opening **44**. The channels **74** and **80** terminate short of the slots **56** and **58** respectively. Additionally, the members **12** and **14** are provided with relatively wide circularly extending channels **82** and **84** around the array of outer depressions **72** and **78**. Channels **82** and **84** continue around to the bottom edges **52** and **54** of members **12** and **14** as shown.

The configuration and orientation of depressions **70**, **72**, **76** and **78** are best seen in FIGS. **4** and **5** which show one of the depressions **72**. Each depression **72** is in the form of a crescent-shaped radially extending depression that is tapered in a circumferential direction (relative to the axis of arbor **46**) so as to have a curved wall **88** which extends substantially perpendicular to surface **38** and an inclined bottom wall **90**. The

depressions in each array are preferably equally spaced from one another and the depressions of one array may but need not be radially aligned with the depressions of the adjacent array on the same surface. The depressions **70** and **76** and the depressions **72** and **78** respectively are located the same distance from the center axis of side openings **43** and **44**. Depressions **70** and **72** may but need not be circumferentially aligned with depressions **76** and **78** when the member **12** and **14** are locked together. However, all of the depressions are oriented so that the direction of rotation of blade **60** is from the deepest to the shallowest portions of the depressions as shown by the arrow in FIG. **4**.

The members **12** and **14** also are provided with means for introducing a liquid to the interior of the guide housing for the purpose of cooling and hydrodynamically stabilizing the saw blade. As seen in FIG. **3**, the members **12** and **14** are provided with inlet ports **92** and **94** that communicate with interior passageways **96** and **98** that open into channels **74** and **80** respectively. The inlet port **92** is tapped to accept a hose coupling **100** and inlet port **94** is tapped to receive a two way coupling in the form of a tee fitting **102**. Coupling **100** and fitting **102** are connected by a flexible base **104**. Fitting **102** also is connected by a hose **106** to a supply of cooling liquid which is delivered to the guide housing under pressure. Preferably, the hose **106** is connected to a supply of cutting oil **108** which serves to lubricate as well as to cool and hydrodynamically stabilize the saw blade. By way of example, the source of supply **108** of cooling liquid may take the form of a pressurized supply tank or a reservoir from which the cooling liquid is fed under the pressure of a motor driven pump. The essential thing is that the liquid be delivered to the interior of the guide means under pressure.

Attached to the outer surface **20** of member **14** is a shield **110** which serves to prevent any liquid from being directed out of the interior of the housing **10** at the machine operator. Shield **110** may, for example, be made of a plastic material and preferably is secured to surface **20** of member **14** by screws **112**. However, shield **110** could just as easily be secured to member **12** instead of to member **14** and the mode of attachment may be other than by screws **112**. Shield **110** projects beyond the face **40** of member **14** so that when the two members **12** and **14** are locked together it will overlap the outer surface **18** of member **12**. The cooling liquid supplied to the interior of the housing is drained out of the bottom via channels **82** and **84** and also by two drain holes **114** and **116** that lead from openings **43** and **44** to slots **56** and **58** respectively. In order to assure that the drain hole **116** will not be blocked by arbor **46**, it is located as near as possible to surface **40** and additionally an axially extending slot **118** is provided as shown to maximize flow of liquid to drain hole **116** and reduce the likelihood of backflow of the same liquid into the arbor housing **16**.

Turning now to FIG. **3**, the arbor **46** preferably has a reduced diameter portion **122** on which is mounted the circular saw blade **60**. Blade **60** is properly positioned on the arbor extension **122** so that its opposite faces are equally spaced from the inner surfaces **38** and **40** of members **12** and **14**. This is achieved by means of a spacer ring **124** made of a rigid metal. The blade is locked in place by frictionally gripping it between spacer **124** and a like spacer **126**. The end of the arbor is threaded to receive a nut **128** which compresses the two spacers together against the saw blade by means of one or more washers **130** as required. The outer diameter of spacers **124** and **126** is kept small in order to expose as much as possible of blade **60** for reasons which will be explained later.

Although any thin flat rotary blade could be used in the present invention, the advantages of the invention are particularly notable with blades of the type designed for cutting and slicing semiconductor crystals. Such a blade is shown in the drawings and comprises a circular thin flat faced body **132** having a square or flat cutting edge **134** of slightly greater thickness. In the typical semiconductor or quartz slicing operation, the body of the blade is made of a high speed steel or phosphor bronze and its side faces must be parallel to within ± 0.0001 inch deviation, while the cutting edge **82** may be made of diamond or other material of suitable hardness. The diameter of the blade is such that its cutting edge extends radially beyond the inner edge but short of the outer edge of channels **82** and **84**.

The members **14** and **16** may be made of an abrasion resistant material but preferably they are made of steel and their surfaces **38** and **40** are treated or coated to minimize wear or damage by abrasion. Preferably they are coated with Teflon in a phenolic resin binder or with molybdenum disulfide in a phenolic resin binder or resin.

The operation of the saw blade guide is as follows. With a blade **60** mounted on arbor **46** as above described and stop pads **40** adjusted for the desired spacing between surfaces **38** and **40**, member **12** is locked to member **14** as shown in FIG. **3**. Then a suitable liquid such as, for example, a cutting oil, is pumped through hoses **106** and **104** from oil supply **108** and the arbor **46** is caused to rotate by a motor driven mechanism forming part of the rotary saw machine (not shown). The oil is injected into spaces between the rotating saw blade and surfaces **38** and **40** via passageways **96** and **98** and grooves **74** and **80** at a selected pressure. The pressure is selected according to the clearance between the blade **60** and the adjacent inner surfaces **38** and **40** of the housing. Typically, the clearance is from one to five mils and the oil pressure is set at about 60–80 psi. The oil flows circumferentially around grooves **74** and **80** and spreads radially over the depressions **70**, **72**, **76**, and **78** and also onto the sides of the blade. Most of the oil is thrown off peripherally due to the centrifugal force of the blade but some moves toward the openings **43** and **44** and is drained off via holes **114** and **116**. The relatively small outer diameters of spacers **124** and **126** permit a large amount of the area of the side faces of the blade to be exposed to the cooling effect of the oil. The blade is made to rotate in the direction shown by the arrow in FIG. **4** with respect to the depressions **70**, **72**, **76**, and **78**. As a result the depressions exert a pressure wedge effect on the oil, creating an axially directed oil pressure against the opposite side faces of the blade. The opposing oil pressures on the opposite faces of the blade **60** are substantially equal, with the result that the blade is hydrodynamically stabilized against lateral movement and lateral vibration.

The oil that is thrown off radially centrifugal force is contained by splash shield **110** and thus is forced into channels **82** and **84** where it flows circumferentially and discharges down onto the workpiece or workpiece support (not shown). The workpiece, i.e., the material to be cut or sliced (not shown) is positioned in slots **56** and **58** for engagement by the cutting edge of the blade **60**. Hence the oil supplied to the housing not only cools, lubricates, and stabilizes the blade, but also cools and lubricates the material being cut.

Because the saw blade **60** is hydrodynamically stabilized when confined in the saw blade guide of the present invention, it is possible to dress the cutting edge without detaching it from the arbor. This is done by operating the machine and stabilizing the blade as above described, and maintaining a dressing tool against the edge of the blade so that a square edge is reestablished on the blade.

Although the depressions **70**, **72**, **76**, and **78** are shown as being crescent-shaped, they may have a rectangular or other configuration in face view provided they are wedge-shaped in cross-section as shown in FIG. **5** and are oriented so that the blade rotates in a direction running from their deepest to their shallowest portions. The wedge-shaped cross-section is what provides the desired stabilizing action.

The size, number, and spacing of the depressions are selected according to the degree of hydrodynamic stabilization required and the diameter of the saw blade. For example, with a six inch saw blade having a clearance of 0.001 to 0.003 inch relative to the surfaces **38** and **40**, it has been found that excellent blade stabilization is achieved if the radial dimension of the depression is about 0.50 inch or wider, the depth of the deepest portion of the depression is about 0.005 inch, the

width of the depressions is about 0.25 inch, and the spacing between successive depressions is about 0.375 inch (the width of the depression is the circumferential dimension which in the case of a crescent-shaped depression as shown in FIG. **4**, is the distance between a radially extending line **138** connecting the tips of the depressions and a parallel line **140** passing along the midpoint of its wall **88**). The size of grooves **74**, **80**, **82**, and **84** also may vary. Thus for a 6 inch saw blade and depressions as just described, it is preferred that the inner grooves **74** and **80** be about one-quarter inch wide and the outer grooves **82** and **84** be about five-eights inch wide. Variations in the size, number, spacing, and shape of the depressions and the size of the grooves is contemplated to be within the scope of the present invention, as is the use of different size guide housings and saw blades, different saw blade clearances and different liquid pressures. However, the crescent-shaped depressions are preferred since they are easy to produce. They are formed by end milling into the surfaces **38** and **40** with a cylindrical end mill disposed at an acute angle with respect to the aforesaid surfaces.

It is to be appreciated that the housing **10** is adapted to be used with various cutting machines having a rotatable motor driven arbor carrying a rotary saw blade. Since such machines are well known and form no part of this invention except to the extent that the invention is usable in combination therewith, it is not believed necessary to describe or illustrate the same in detail.

I claim:

1. A guide for hydrodynamically stabilizing a rotary saw blade mounted on a rotatable arbor comprising:

a housing having therein first and second opposed surfaces that define a narrow space therebetween for receiving said saw blade and a side opening in at least one of said surfaces for accommodating said arbor, said housing also having means enclosing all but a portion of said space so as to provide another opening through which said blade extends for engaging a workpiece;

passageway means within said housing for injecting a liquid into said space; and

means on said first and second surfaces for directing said injected liquid against and at a right angle to the opposite faces of said blade during rotation thereof so as to substantially hydrodynamically stabilize said blade.

2. A guide as set forth in claim **1** wherein said housing comprises first and second separable members and said first and second inner surfaces are integral with said first and second members respectively, and further including means for securing said members in fixed relation to one another.

3. A guide as set forth in claim **2** further including means for adjusting the spacing between said members.

4. A guide as set forth in claim **2** wherein said members are hingedly connected to one another by a loose hinge pin.

5. A guide as set forth in claim wherein said side opening is located substantially perpendicular to said surfaces.

6. A guide as set forth in claim **1** further including means in said housing for draining said liquid from said housing.

7. A guide as set forth in claim **1** further including channel means within said housing for directing said liquid to flow to said another opening.

8. A guide as set forth in claim **1** wherein said passageway means comprises two passages leading from outside said housing to said first and second surfaces.

9. A guide as set forth in claim **1** wherein said liquid directing means comprises first and second like circular arrays of depressions on said first and second opposed surfaces respectively, said depressions on each of said surfaces shaped to create an axially directed liquid pressure on the opposite faces of said saw blade.

10. A guide as set forth in claim **9** further including an additional circular array of depressions on each of said opposed surfaces in radial spaced relation to said first and second arrays of depressions, and a groove between the two arrays of depressions in each opposed surfaces through which said injected liquid is distributed in said space to said depressions.

11. A guide as set forth in claim **9** wherein the depressions in each array are equally spaced from one another and are of a uniform size.

12. A guide as set forth in claim **9** wherein each of said depressions is tapered circumferentially about said side opening.

13. A guide as set forth in claim **12** wherein each of said depressions is crescent-shaped.

14. In combination with apparatus comprising an arbor support, an arbor rotatably mounted in said support, and a saw blade mounted on one end of said arbor, the improvement comprising means for hydrodynamically stabilizing said saw blade, said stabilizing means comprising a housing attached to said arbor support having a side opening in said housing through which said arbor extends, said housing also having first and second surfaces disposed in confronting spaced relations to each other, said blade extending into the space between said first and second surfaces and being spaced axially from each of said surfaces, means for injecting a liquid into the space between said first and second surfaces, and means on said surfaces for directing said liquid against the adjacent faces of said blade so as to substantially hydrodynamically stabilize said blade during rotation thereof.

15. The combination of claim **14** wherein said last mentioned means comprises at least one circular array of depressions on each of said surfaces, said depressions being shaped so as to create an axially directed liquid pressure on the opposite faces of said saw blade.

16. The combination of claim **14** wherein said housing further includes means for channeling said liquid out of said housing.

17. The combination of claim **14** wherein a portion of said blade projects out of said housing a distance sufficient to engage a workpiece, and means for channeling said liquid from the interior of said housing to said workpiece.

18. The combination of claim **17** wherein said housing has a transversely extending slot in the region where said blade projects from said housing.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,661,045 Dated May 9, 1972

Inventor(s) Seymour Mermelstein

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, Line 54 of Claim 5, insert "2" after the word --claim--.

Signed and sealed this 19th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334